



Facts and results from the Stockholm Trials

First version – June 2006

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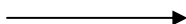
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Expert Group's conclusions

Presentation of Expert Group

The Expert Group consists of eight traffic experts with various specialities. The group read all documentation and then, during three intensive full-day seminars, drew the conclusions presented in this summary of the evaluation of the Stockholm Trial. Several group members have in different ways participated in preparatory tasks prior to the evaluation and also conducted follow-up activities during the course of the trial. In August, when further reports will be available, the evaluation will be supplemented by additional material.

The Expert Group is chaired by Jonas Eliasson and its secretary is Lena Smidfeldt Rosqvist. Other members are Staffan Algers, Karin Brundell-Freij, Cecilia Henriksson, Lars Hultkrantz, Christer Ljungberg and Lena Nerhagen. A more detailed presentation of group members is contained in Appendix 1.

Effects of the congestion tax in Stockholm were as predicted

Expectations concerning the Stockholm Trial were many, as were uncertainties about how its effects would be influenced by the fact that the trial period was limited. Numerous questions centered on whether such a limited trial period would result in the large effects indicated by traffic models - road users/passengers might choose to “sit out” the trial period and not adjust their travel patterns. Now, when we to a large extent know what the actual effects were, many of these questions can be answered.

Even before the Stockholm Trial started, most people were well aware that motorists are sensitive to economic incitement so expectations that the congestion tax would reduce traffic volumes were therefore well grounded. In the first place, it was anticipated that the reduction would be seen near the congestion-charge zone, with a relatively quick fall in the reduction as distances to the charge zone lengthened. Even if prognoses were made regarding the effects of the Stockholm Trial, the exact size of the reduction was naturally uncertain.

Expected effects on accessibility were more doubtful than those for traffic volumes. There was reason to believe that limited traffic-volume reductions could lead to a “leap” effect in the form of less congestion but there was much uncertainty about this since the connection between traffic volumes and travel times/congestion is very complicated.

As to traffic passing over the congestion-charge zone cordon, it was expected - based on developments in London - that the Stockholm Trial would result in many motorists leaving their cars at home and instead traveling by public transport or, to a certain degree, by cycle. The expected increase in travel by public transport was not entirely due to the congestion tax - the expansion of public transport as part of the Stockholm Trial also played a role. As a direct consequence of reduced traffic, road safety

for motorists was also expected to improve, particularly as regards whip-lash injuries. However, the trial period is all too brief to enable these changes to be measured.

The Stockholm Trial also has a distinct environmental profile, which is natural since vehicle traffic contributes to a number of our most urgent environmental problems, not least in large cities. Even if the congestion tax, as initially proposed, was primarily aimed at reducing congestion, it is obvious that by reducing traffic it is also expected to have effects on the environment and citizens' health. Uncertainty regarding expected effects in the form of reduced exhaust emissions derived from uncertainty about the size of traffic reductions.

It is, however, not obvious which health effects - and their size - will result from changed emission volumes. The connection between vehicle emissions and air-pollution levels affecting health in Stockholm are extremely complicated.

The Stockholm Trial was expected to result in only small changes in noise levels, since large traffic-flow reductions are necessary to achieve improvements in noise levels. A 50% decline in traffic flow would yield a fall in noise levels of 3 dBA, a barely audible change.

What change citizens would perceive in the city environment due to the Stockholm Trial was a matter of great uncertainty, not least because the city environment is a complicated concept that lacks a clear-cut definition.

The exemption of clean vehicles from the congestion tax, for example, was expected to lead to an increased number of such vehicles in Stockholm traffic. It was also expected that there would be an increased number of company cars since this is category of users less price-sensitive than others.

Finally, we were all curious as to whether the effects of the Stockholm Trial would be felt even without monitoring, i.e. whether Stockholm citizens and visitors would spontaneously note them.

Documentation for the summary of our conclusions

The evaluation of the Stockholm Trial includes a large number of monitoring and studies that date from three periods, two prior to the start of the Stockholm Trial and one after: (1) August 2005, with expanded public transport; (2) autumn 2005; and (3) the months after the introduction of the congestion tax in January 2006. Individual studies have been initiated in cooperation with the Swedish Road Administration, the Stockholm County Council regional planning and traffic unit, Stockholm Transport (SL), various research institutes, certain City of Stockholm administrative offices and experts from other bodies, organizations and companies.

The studies cover a large number of fields, including not only travel habits and their effect on vehicle traffic and public transport but also envi-

ronmental consequences, effects on the retail market and business economy, pedestrian and cycle traffic, changes in the city environment and effects on national and regional economies. Many of the effects of the Stockholm Trial are strongly dependent on external factors, for example economic trends in the Stockholm region and Sweden as a whole. As a result, the evaluation also includes studies of the retail market and the general economic situation. Between monitoring periods before and during the Stockholm Trial there were external factors that influenced effects monitored in the various studies. The most important factors were that petrol prices went up and the Södra Länken bypass tunnel was opened. These and other such factors that affected results have been taken in account in the conclusions made by the Expert Group and herewith presented.

A comprehensive follow-up and evaluation of the effects of a project the size of the Stockholm Trial is a difficult task which has not been made easier by the short time available to conduct the follow-ups. Regarding methods, there are numerous factors that are difficult to handle. Of these, we have already mentioned the influence of external factors on effects. Several of the studies took the form of panel studies, i.e. the same persons were questioned about their behaviour prior and during the Stockholm Trial. These panel studies have many advantages but also call for caution when drawing conclusions since there was an age disparity between monitoring prior to and during the trial. Moreover, the trial is not yet completed and much of the documentation is based on studies from spring 2006, that is, after half of the trial period.

In our evaluation of the result/conclusions of studies, we have taken into account the stability of individual studies, the expected stability of monitoring results and which monitoring methods were used. We have also taken account of the importance and potential of various effects. Thus, we do not base our evaluations solely on the results of individual studies but also on appraisals of significance and general applicability vis-à-vis effects.

Results

Vehicle traffic declined more than expected

Traffic goals of the congestion tax were that the number of vehicles passing over the charge cordon during the morning and afternoon/evening peak periods should decline by 10-15% and that accessibility should improve on Stockholm roads with the heaviest traffic. The congestion tax was designed to meet these goals but uncertainties regarding the effects of the tax, as earlier mentioned, were many. Numerous monitoring, of various types, were conducted and analysed to produce information on traffic changes.

The main features of the traffic reductions are crystal clear. The Stockholm Trial cut traffic flows - more than expected, in fact - the decline

being surprisingly stable, taking into account normal seasonal variations during spring. In addition, the effects of the trial were seen further out from the charge zone than we initially expected - traffic volumes declined at locations far from the charge cordon. Consequently, many of the feared side-effects - on link roads at the city's outskirts, for example - were unfounded. The decline in traffic volumes was measured via traffic monitoring but has been demonstrated in special studies as well.

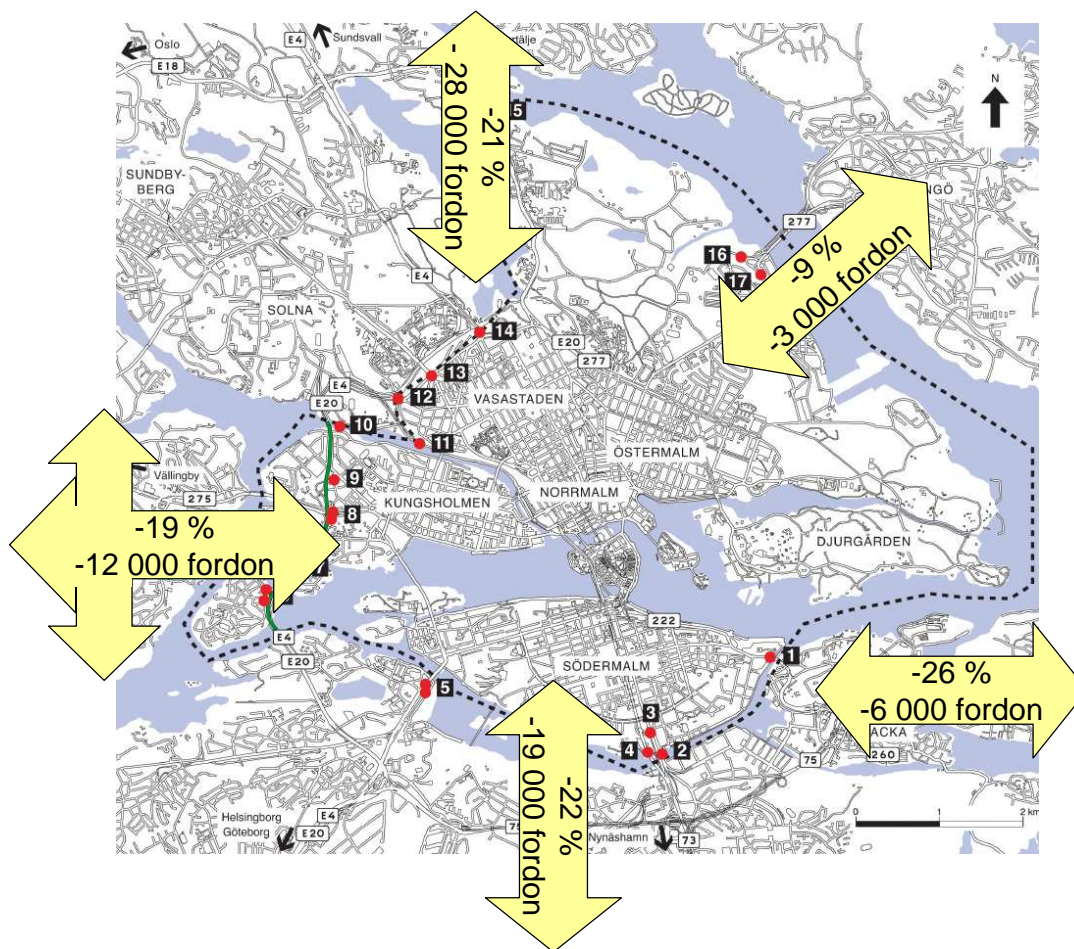
Exactly as expected, the biggest traffic decline was in vehicles passing over the charge cordon, which includes all approaches to the inner city. For an entire day's charge period (24 h), the decline was about 22%, equivalent to 100,000 passages over the charge cordon.

The decline in vehicles passing over the charge cordon was biggest during the morning and afternoon/evening peak periods. The biggest decline of all was during the afternoon/evening peak period, which can be probably be partly explained by the fact that during the afternoon/evening travel is not dictated to the same extent by time/destination as in the morning peak period's journeys to work. Traffic also declined during evenings after the charge period. The reason may be fewer outward/return journeys by car during the charge period, resulting in fewer return journeys during evenings after the charge period. We hope to provide a better explanation in August in connection with our updated analysis, in which we will analyse the major travel-habits survey.

The traffic decline on the southeast approach road was bigger than the average decline for the entire charge zone. The decline to/from Lidingö, on the other hand, was less than the average. This was expected, since traffic to/from Lidingö that passes through the charge zone within a 30-minute period is not subject to the congestion tax. Regarding the fact that the traffic decline is bigger from south/southeast, it is conceivable that the reason is that the percentage of through traffic is higher and consequently more drivers can choose to drive round the inner city to avoid the congestion tax. Hopefully, the travel-habits survey will provide a more detailed explanation.

Traffic flows on big inner-city streets during the charge period declined but not as much as over the charge cordon. This is natural since the traffic flow in the inner city also includes vehicles belonging to people who live there, etc., who do not leave the charge zone but use their vehicles for transport within the zone. There are also signs from studies other than traffic monitoring that motorists who do not need to pass over the charge cordon benefit from the decline in congestion and, in fact, now use their cars more often. This could partly explain why the traffic-flow decline in the inner city is lower.

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-21%
-28,000 vehicles

-9%
-3,000 vehicles

-19%
-12,000 vehicles

-22%
19,000 vehicles

-26%
-6,000 vehicles

Figure 1. Change in traffic flows over charge cordon during charge period (6.30 a.m.-6.30 p.m.) per direction.

Fears of collapse on Essingeleden and other bypass routes were unfounded. Differences everywhere are small if compared to normal week-by-week variations.

Traffic in Södra Länken has continually increased since it opened in October 2004. It is impossible to determine to what degree the increase in 2006 is due to the congestion tax. Normally, new infrastructural devel-

opments have a long “running-in” period and, in addition, the large number of people moving to Hammarby Sjöstad (a new housing district in the southern part of Stockholm) has certainly led to traffic increases. These effects, together with an accident causing lane closures on Essingeleden in October 2005 (a floating crane collided with one of the bridges), influenced both traffic volumes and the reliability of traffic monitoring. We have taken account of this in our evaluation.

The only approach that deviates from the pattern of shorter travel times is Värmdövägen (from Nacka Centrum to the entrance to Södra Länken). The increased traffic in Södra Länken also causes longer queues on Värmdövägen westwards in the morning peak period. Travel times, however, are significantly shorter than previously after this point, i.e. the continuation of Värmdövägen-Stadsgården westwards in towards the city. There is a similar trend on Nynäsvägen.

According to manual monitoring of approach-road traffic, the number of commercial vehicles passing the charge cordon has also declined. The manner in which commercial drivers have changed their travel habits is, however, uncertain.

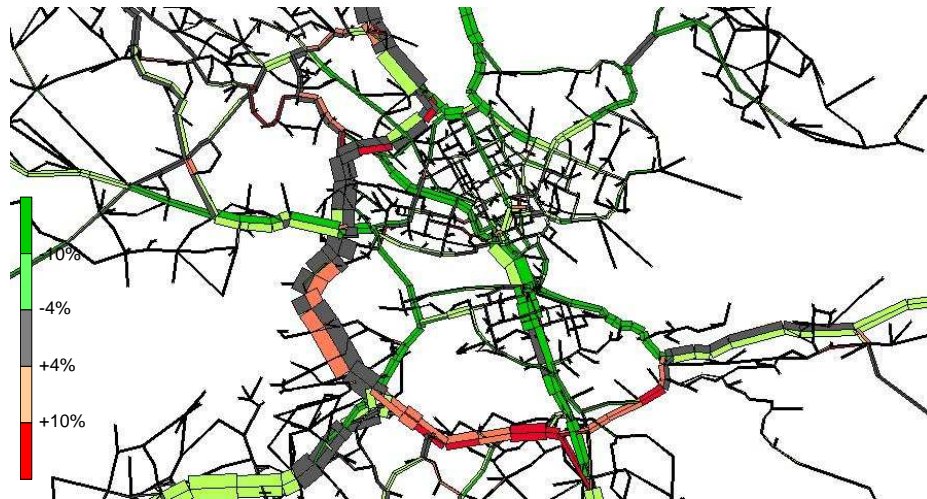


Figure 2. Change in traffic volumes (weekdays, 24-hour period), April 2005 compared to April 2006.

Congestion rose at the end of April in line with the annual spring increase in traffic and it has been discussed whether this was due to the effects of the congestion tax declining over time. It is true that congestion has increased but it is the result of a normal seasonal increase in traffic. The effects of the traffic decline are, however, the same in a month-by-month comparison with earlier years. A probable contributing factor to the increase in congestion - in addition to the increase in traffic - is that the number of cyclists and pedestrians also went up with the arrival of spring. They also utilize traffic-system capacity. Another interesting reflection is that if the traffic decline is equally large during the entire period, taking account of the first half-year’s seasonal variations, it means that additional vehicle journeys made during the spring were just as much affected

by the congestion tax as those made when the Stockholm Trial began during the winter.

Accessibility improved

A consequence of vehicle traffic declining is that accessibility improved and travel times fell. This had a large, positive influence on the reliability of travel times, i.e. travellers were now more certain that a journey could be made within a given period. Travel times for vehicle traffic declined significantly in and near the inner city. Particularly large declines were seen on approach roads, on which queue times fell by one-third during the morning peak period and by one-half during the afternoon/evening peak period. This is an important improvement for car commuters to/from the inner city since it means that travel times are shorter and more reliable. When high congestion occurs, disparities in travel times on the same stretch with different traffic conditions - which can vary from day to day - are very big.

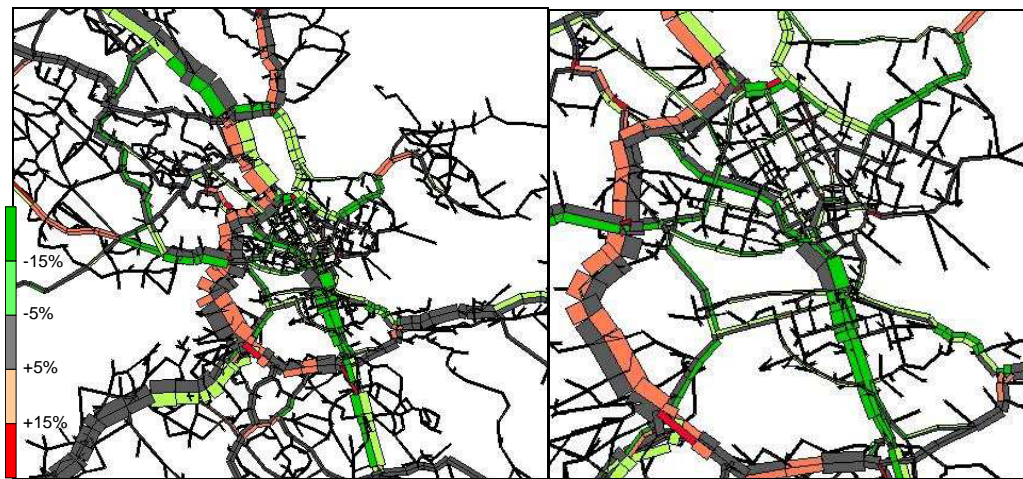


Figure 3. Change in travel times (morning peak period), April 2005 compared to April 2006. Inner city enlarged (right).

The relatively high congestion on Essingeleden means that travel times vary greatly from week to week, even if traffic volumes are generally unchanged. In the light of the traffic increases we can see on Essingeleden, it is reasonable to believe that travel times have increased. However, in the monitoring done between 2005 and 2006 no increase in travel times can be seen.

Traffic increases in Södra Länken lengthened travel times there compared to 2005. With available data, it is impossible to say how much of the traffic increase is due to the congestion tax and how much is the result of a traffic increase that would have occurred irrespective of the congestion tax. We can, however, say with certainty that there is great deal here that is not the result of the Stockholm Trial.

It is clear that the decline in traffic volumes and improved accessibility has led to a better work environment for commercial drivers, seen in vary-

ing measure in all studies with commercial drivers - bus drivers, taxi drivers, couriers and trades people - conducted before and during the Stockholm Trial.

Traffic declines result in less damage to the environment and better health

Vehicle exhaust emissions constitute a large part of the total amount of pollution in a city. Released into the air, emissions mix with other pollutants and thus affect air quality. Different pollution or exhaust-emission substances have various types of effect. Sometimes it is the level of pollution - numerous emissions mixed in the air - where people are that is most significant and sometimes it is the total amount of emissions. Regarding carbon-dioxide emissions, which are important for the greenhouse effect, it is the total amount of emissions that is decisive. Air quality, mainly measured by particle levels, affects the health of people in a city, resulting in increased heart, vascular and lung diseases as well as increased discomfort for sensitive groups (asthmatics and people with other bronchial disorders as well as those suffering from heart and lung diseases).

Total exhaust emissions caused by vehicles is due to both total vehicle kilometres travelled - i.e. the total of distances covered - and exhaust-emission factors, i.e. emission of different substances that each vehicle emits per driven kilometre.

Total kilometres travelled multiplied by emission factors results in total amount of exhaust emissions (expressed in, for example, tons/year) for different substances. Emission factors are influenced by vehicle-park composition and how vehicles are driven. For example, a driving style with many speed variations produces more emissions than one with a more uniform speed. These relationships are complicated and it is therefore difficult on the basis of input data to exactly calculate the result of the Stockholm Trial in the form of reduced emissions. Emission calculations carried out were done on the basis of various emission models which differ in regard to which factors are taken in account when making the calculation. However, calculation results are similar. Assumptions made in the calculations probably mean that, in any case, effects have not been exaggerated. The calculations primarily show that a decline in traffic volumes leads to reduced emissions but also that it is changes in vehicle-park composition that are decisive as regards how much the emission of particles/nitric oxides falls.

The Stockholm Trial led to reduced emissions of both carbon dioxide and particles. The reduction of carbon dioxide is approximately proportionate to the decline in vehicle kilometres travelled, which means that the effect of traffic on exhaust emissions dropped by 2-3% in Stockholm County and about 14% in the inner city. As the result of one measure - the Stockholm Trial - this is a major reduction even if the decline in Stockholm County can only be seen as an interim step if the aim is to meet national climate goals. Carbon dioxide emissions are the traffic emissions most difficult to reduce.

The total decrease in the amount of particle emissions is similar to that for traffic volumes but for these substances the most significant factor is *where* the reductions take place since they contribute to local pollution levels. The Stockholm Trial has led to an approximate decrease in the effect of traffic on pollution levels by one-twentieth for the County of Stockholm and one-tenth for the inner city. According to the Stockholm County Council, reduced use of studded tyres is an important step in meeting the environmental quality standard for particles. In the case of Hornsgatan in Stockholm's Söder district, a 10% fall in the use of studded tyres would result in a reduction of pollution to levels equivalent to the decrease that the City of Stockholm's Environmental Office calculated that the congestion tax would produce. However, the fact is that the congestion tax, in addition to reducing particle counts (measured in PM10) at street level, even leads to a reduction in the level of smaller exhaust particles, which is also a benefit to health - a benefit that cannot be gained by reducing the use of studded tyres.

There are also environmental quality standards for nitrogen dioxide, NO₂. The NO₂ count at street level is decided not only by vehicle emissions but even by factors such as the occurrence of other substances. Vehicle emissions of nitric oxides (NO_x - not only NO₂) have declined continually during recent years due to stricter vehicle-exhaust regulations. The effect of this decline on NO₂ counts at street level in Stockholm's inner city is, however, much lower. This is the result of the complexity of, for example, chemical reactions. Thus, it cannot be expected that the congestion tax will be of any great significance in meeting NO₂ environmental quality standards.

Exposure to particles affects the population's health and mortality rate. Calculations based on the connection of congestion-tax effects to early mortality due to exposure to air pollution show that traffic reductions resulting from the Stockholm Trial save about five otherwise "lost" years. That is also the expected reduction used in the cost-benefit calculation for the Stockholm Trial. New research results, presented in an evaluation report, indicate a significantly higher saving. Calculations based on the new research results point to the avoidance of about 25-30 early deaths, equivalent to about 300 years.

Bearing in mind that there is thus an obvious risk that health effects may be larger than what has traditionally been expected, one should not ignore the importance of reduced exposure. To get the best result from a measure aimed at reducing exhaust emissions, activities should be focused on areas where population density is highest and, consequently, many people are exposed to emissions affecting their health. Via the congestion tax, emissions can be controlled according to where the tax is levied. Consequently, the effects of the congestion tax have a larger influence on health per given emission amount than a petrol-tax increase. The emission reduction in the inner city resulting from the congestion tax has, for Stockholm County as a whole, a health effect that is about three times as big as the health effect that would have resulted from a decline deriving from a rise in petrol prices evenly distributed throughout the county.

As expected, the Stockholm Trial in general has led to only small changes in noise levels since large traffic-flow changes are necessary to perceive an increase/decrease of noise levels.

Anything less than 3 dBA will not be perceived as a difference in noise levels which, as regards traffic, is equivalent to about a doubling or halving of traffic volumes.

Calculations of noise-level changes due to the Stockholm Trial reveal changes of 1 dBA or, at most, 2 dBA for average levels over a 24-hour period. There are, therefore, an extremely small number of locations where changes in noise levels can be perceived. However, even minor noise-level changes of 1 dBA mean that the part of the population that feel disturbed by traffic noise declines. Perception of noise levels can also improve if one experiences less congestion and vehicle traffic. In the city-environment study there are results indicating that people believe there is less noise now in spite of the fact that, in principle, it is impossible to perceive the small noise reductions that have taken place.

Noise continues to be a big problem in Stockholm, as in many other places in Europe, and is now the subject of a special EU directive. One goal is to create quiet zones, which puts large demands on traffic reductions. It is difficult to see how such traffic reductions could be achieved without very effective steering measures to limit vehicle traffic.

Public transport important part of the Stockholm Trial

Accessibility for bus traffic to/from and in the inner city has increased. Since inner-city timetables were not adjusted for the trial period, improved accessibility has not significantly shortened travel times for inner-city buses. Punctuality has probably improved and as regards bus traffic passing over the charge cordon travel times have shortened considerably.

Efforts to improve public transport (park-and-ride sites, expanded bus and light rapid-transit train services) did not, on the basis of current documentation, yield any visible effect on the total number of public-transport journeys during autumn 2005 - before the start of the Stockholm Trial. That is not say there is no such effect, just that, if it exists, it is too small to register in SL's passenger statistics or in the travel-habits survey conducted in autumn 2005. It is indeed improbable that the public-transport expansion would not have *any* effects on the total number of public-transport journeys but adequately detailed analyses and statistics enabling such an increase to be identified are not yet available. SL's onboard surveys on the new buses indicate that it has enticed motorists to switch to public transport but their number is still too small to make an impression when considering total public-transport travel. Totally, travel with SL was about 2% higher in autumn 2005 compared to autumn 2004 but that increase is believed to be due to higher petrol prices.

Public-transport travel was about 6% higher in spring 2006 than in spring 2005. The congestion tax seems to have increased public-transport travel by about 4.5%, while higher petrol prices and other external factors are probably responsible for the rest of the increase (about 1.5%). Congestion on public transport (measured by the number of standing passengers) in-

creased somewhat on the Underground and decreased on commuter trains. Overall, congestion seems to be unchanged, probably partly due to expanded public transport.

Another question is if the congestion tax would, in fact, have reduced vehicle traffic even if public transport had not been expanded. Expanded public transport, as mentioned above, has as yet certainly not provided any evidence of an increase the number of public-transport journeys,¹ but it is quite conceivable that it boosted the effect of the congestion tax by making the switch from car to public transport easier. If that is the case, part of the effects of the congestion tax should instead be registered as an effect of expanded public transport.

Still, we believe that that effect, even if it exists, must be small. We base this belief on the fact that onboard surveys on the new buses show that, between autumn 2005 and spring 2006, the number of new passengers who earlier used their cars for transport was tiny compared to the reduction in the number of passages over the charge cordon. Of the vehicle-traffic reduction of 22% over the charge cordon, at the most 0.1% can be ascribed to expanded bus traffic.

Problems with commuter-train traffic during the winter seem to have led to reduced travel on these services. It is unclear which alternative mode of transport passengers chose. Some have certainly used other public-transport alternatives or refrained from travelling while others have instead used their cars. Commuter-train problems should therefore, to a certain degree, have limited the traffic reduction resulting from the congestion tax.

Road safety improved as a result of reduced traffic

Road-safety effects are, without exception, difficult to evaluate and the short period of the Stockholm Trial makes it hard - not say impossible - to draw conclusions on the basis of follow-ups of actual and reported accidents during the trial. Evaluations of the road-safety effects of the trial are therefore based on estimates and the connection between road safety and changes in traffic volumes, traffic flows and speed levels.

Research shows that road safety is mainly influenced by changes in traffic volumes and speed levels. Since traffic declined as a result of the Stockholm Trial that means that even the estimated number of accidents within the charge zone in which people were injured is lower. The size of the reduction in accidents is, of course, uncertain but based on model estimates the number of accidents where people were injured should have fallen by about 9-18%. Reduced congestion should also have led to higher speeds, resulting in an expected increase in the number of accidents where people were injured. This effect, however, is not as big as the effect of traffic reductions.

The total effect of the Stockholm Trial on road safety is undoubtedly judged to be positive since the positive effects of the traffic reduction are expected to be bigger than the negative effects caused by higher speeds. A

large number of road accidents within the charge zone occur during the charge period. A cautious estimate is that the Stockholm Trial has led to a reduction in the number of accidents within the charge zone where people were injured by 5-10%. Converted to yearly values, this would equal an annual reduction of between 40 and 70 accidents in which people were injured. This can be seen in the light of the fact that, on average, 2,155 people are injured and 23 people die in road accidents per year in Stockholm County.

¹ Note: We are talking about the effect *seen to date*. It is quite likely that, eventually, more detailed statistics and analyses will reveal an effect.

The majority of those who are injured, both in the county and inner city, are motorists. In the inner city, just over a third of those injured are unprotected road users.

Difficult to judge whether Stockholmers think the city environment has improved

The city environment is complex and diffuse concept. It is difficult to find a common, clear-cut definition of what is meant by a “good” or “improved” city environment. It is also difficult to measure these types of effect. Since a perceived improvement in the city environment is one of the goals of the Stockholm Trial we have, in spite of documentation that is hard to analyse, tried to make an evaluation. To draw conclusions from the study carried out is made difficult not only by the above-mentioned general problems but also by the completely different weather conditions during the two monitoring periods. Our conclusions are therefore very cautious.

The result points to perceived improvements of exactly those factors for which measured changes can be demonstrated, i.e. those connected to traffic reductions. In the city environment study, citizens feel there is an improvement in traffic tempo, air quality and vehicle accessibility. The same tendency is seen in interviews with cyclists in the inner city and children living in the inner city. Inner-city children’s perception of the city environment has very clearly improved and many cyclists think there are fewer cars in the inner city and that the traffic environment has got better. Perception of things that have got worse mainly concerns accessibility - by foot and cycle and on public transport. The result does not support any clear-cut or unequivocal appraisal of whether the city environment in general has improved. Perceptions of accessibility by foot or cycle are strongly influenced by the weather and season and monitoring took place at different periods. However, the conclusion is that effects clearly associated with traffic changes can be seen in how the city environment is perceived.

Many ways of adjusting to the new situation

If the congestion tax is introduced permanently, there will be both short- and long-term adaptations. Because the Stockholm Trial is just a trial – and a short one at that – one can only expect short-term adaptations. This is all we have measured and all we can evaluate. In the long term, there

will also be localization effects, discussed in the section about the effects on the regional economy. There are even possible long-term effects at an individual level. For example, it may be, in a slightly longer perspective, that part-time workers will reorganize their work time to reduce the number of journeys subject to the congestion tax.

There is a wealth of different strategies for adjusting to the new situation created by the Stockholm Trial. We have searched the evaluation material for anything sufficiently of note to show up in monitoring and test results. At an individual level, there are even more variations than the ones we comment on. It is important, in the meantime, to remember that in discussions about the different adjustment strategies, only a small portion of county citizens' journeys are affected by the congestion tax. Prior to the Stockholm Trial, county citizens made about 300,000 vehicle journeys per day over the charge cordon during the charge period. This is equivalent to 14% of all *car passages* and 7% of *all passages* during one work day in the county. Most of these journeys were work-related.

There are two different types of adaptations which point in two different directions. One is to adapt in order to avoid the congestion tax one way or another, which reduces traffic. The other is to utilize the lack of congestion which is the result of the reduction in traffic, which counteracts the reduction in traffic. A further adjustment to avoid the congestion tax is to use a clean car which – not unimportantly – reduces damage to the environment. Increased use of clean cars does not, however, reduce congestion.

It is very clear that vehicle traffic has fallen, especially in the inner city. Not only private motorists but also commercial traffic seems to have adjusted travel habits. According to manual calculations of approach-road traffic over the charge cordon, car traffic has been reduced by 30 %, light trucks by 21 % and trucks by 13 %.

There is much uncertainty over how many of car journeys have instead been replaced by travel on public transport. According to SL, some 40,000-50,000 new trips are being made with public transport. If this is so, it is not even half the number of car journeys no longer being made over the charge cordon. Hopefully, analysis of SL's measurements and the summer's survey of travel habits in Stockholm County will provide a clearer picture of what has occurred. The new park-and-ride sites introduced for the Stockholm Trial have largely been filled, but it is not clear if this is the result of the congestion tax or the result of a need which has now been met. The increase in park-and-ride sites (approximately 2,000 cars per day) is almost insignificant, however, in relation to the number of vehicles passing over the charge cordon (about 530,000 passages per 24-hour period prior to the introduction of the congestion tax) or to the reduction in traffic (about 100,000 fewer passages per 24-hour period). Each individual vehicle can make several journeys.

Several of the results from the evaluation imply that some motorists have changed the time at which they travel. This is, however, not the only ad-

justment to journeys, as some studies of adjustment of travel times prior to the Stockholm Trial showed. Journeys have more likely been reorganized to become fewer or more efficient and also changed to include other means of transport.

Calculations of the average number of passengers per car also show that shared travel has not increased to any measurable degree. The average number is stable at 1.27 people per car.

Because public transport, pedestrians and cyclists have not collectively increased as much as vehicle traffic has decreased, this must mean that some travel has simply “disappeared”, especially as cycling has, moreover, decreased in the monitored periods. The adjusting mechanisms remaining as explanation for what has happened with car journeys are that people have chosen other routes or closer destinations, that people have coordinated errands so they can be achieved with fewer trips and that some trips are simply not being made.

Despite the fact that approximately half the vehicle journeys over the charge cordon which have “disappeared” are now being made by public transport, it is interesting to note that the “amount of travel” in the previous situation is not a static fixed number which can be replaced, but that there is a large adjustment potential in simply reducing travel in different ways. The early result of surveys of travel habits seems to point to a reduction in the frequency of travel – people are not making as many trips as they did prior to the introduction of the congestion tax. A reduced frequency of vehicle journeys over the charge cordon can even be seen in the study of commuter trips from the Stockholm/Mälaren region to Stockholm’s inner city and in the study on attitudes, where people now say they make fewer trips to the inner city. Even large changes in heavy traffic (seen in the manual calculations of approach-road traffic) support the reasoning and explanations of route planning and information given by transport companies.

Adjustments in the form of taking advantage of reduced congestion on roads are seen, for example, in the study of work travel to/from two large workplaces. Among these commuters, there are now several who don’t need to cross the charge cordon and who now travel in peak-period traffic. Among these commuters who live and work outside the charge cordon, the percentage choosing a car as transport has increased somewhat. Further examples of this are that because there is a smaller traffic reduction in the inner city than over the charge cordon, people now choose Klarastrandsleden, because it is now possible to travel there without hinder. There are, therefore, many people who do not pay, but who are still able to take advantage of improved accessibility.

People have become more positive as they have experienced the effects

We have not yet had access to the complete analysis of the attitude survey presented in the summer. Conclusions are based on the “monthly indica-

tors”, excerpts from result tables from the attitude survey as well as studies of company attitudes.

It is clear that both the public and companies have become increasingly positive towards the congestion tax and the Stockholm Trial, as they have gained their own experience and as benefits have begun to appear. This is normally what the acceptance of change looks like: Without individual experience, people see almost exclusively barriers and costs, but with individual experience they begin to discover the advantages and benefits gained for these costs. There is, however, a lot of uncertainty over how fast these changes in attitude take place.

The percentage of Stockholm County citizens who think there is a problem with congestion has fallen compared to the period prior to the introduction of the congestion tax. Even attitudes to the Stockholm Trial have become more positive during this time. In autumn 2005, about 55% of all county citizens believed that it was a “rather/very bad decision” to conduct the congestion-tax trial. Since the congestion tax was introduced in January 2006, this percentage has continuously fallen. In April and May 2006, 53% believed that it was a “rather/very good decision” while 41% believed that it was a “rather/very bad decision”. Significantly, even those travelling by car to/from the inner city during the charge period in the most recent two 24-hour periods have become more positive by several percentage units.

As with the general population, companies have moved from being primarily negative to more positive, both to the Stockholm Trial and to the congestion tax as a permanent measure. The shift is more apparent for the trial itself than for the congestion tax as a permanent measure.

Companies are, as far as we can tell, united in their criticism of the inconvenience and the administrative costs the congestion tax bears in its current form. There is even evidence that companies still believe that the system is hindering growth, but while there were opinions before the Stockholm Trial that *both* the individual company and other companies would be affected negatively, opinions are now more moderate regarding the individual company’s negative development.

In attitude surveys, it is clear that the reason for choosing to drive a vehicle compared to before the Stockholm Trial is now increasingly that it is possible to save time compared to other means of travel. There has been a decline among those who choose public transport due to too much traffic and queuing. This is interesting, because it means that improvements in accessibility which can be measured objectively have also been visible “to the naked eye”.

It also appears that people using public transport are very satisfied with the direct buses.

Motorists with company cars are a group where it is harder to judge the adaptations made. This is because the actual cost of the congestion tax for

private travel is sometimes paid for by the employer, sometimes by the employee. There is also an in-between variant, where the employee pays via a gross-salary deduction, which means that the actual cost of the congestion tax is significantly reduced. We do not have a clear picture of how the different variants have been applied during the Stockholm Trial. In the study of two workplaces, it was clear that Swedish Postal Service employees will eventually be debited for congestion-tax charges for private journeys.

It is reasonable to say that company-car motorists pay less, on average, to pass the charge cordon than private motorists. We also expect company-car motorists to be less price-sensitive because of their on-average higher incomes. Manual calculation of approach-road traffic also shows an increased percentage of company-car motorists passing over the charge cordon.

The technical system works

We would have liked an assessment of how the technical system has worked. Because we do not currently have this kind of evaluation we can only make an overall estimation. We know that we cannot assess how complicated the congestion-tax system is for each individual and/or organization at an overall level.

We can, however, conclude that on an average day in May 2006, 371,300 journeys took place over the charge cordon, resulting in 115,100 tax decisions and income of more than SEK 3 million. Of these 115,100 tax decisions, 100 were investigated by the Swedish Tax Agency and five were appealed. The Swedish Road Administration customer-service unit received on an average day in May 2,200 calls, as opposed to an expected 30,000 calls. Based on this, our assessment is that the system generally worked well. The case studies carried out imply the system needs adjustment to reduce inconvenient administration for companies.

There is reason to note that red-tape costs for both individuals and companies are now absent from cost-benefit evaluations. It is probable that many experienced the initial inconvenience as high but that it has fallen as people have learned how payments can be made in the simplest way.

Benefits and costs distributed differently

Results of the travel-habits survey and analysis of distribution effects for various group affiliations are not yet available. This section will therefore be supplemented in August with an analysis.

Based on the first evaluation of the expansion of public transport in the autumn of 2005, it was, as expected, mainly people of middle income who changed from car to public transport, as well as people with children and people born overseas. It is normally primarily people of middle income who change, which can be explained by the fact that people of low income already use public transport and that the incentive for people of high income to reduce their car travel is not as strong.

The main “winners” of the congestion tax are:

- Public-transport travelers who get a better choice.
- Those who drive cars without passing the charge cordon and therefore have shorter travel times at no extra cost.
- Cyclists who appear to have a better traffic environment.
- People who value their time highly and think that more time is worth money.
- Commercial drivers who gain a better work environment (bus drivers, taxi drivers, truck drivers, etc.).

The main “losers” are:

- Those who drive a car over the charge cordon and for various reasons cannot adapt their travel and who don’t think more time is worth money.
- Those who are “forced off” the roads.
- Public-transport passengers who experience more public-transport congestion.

Marginal effect on regional economy

The regional economy may be affected both in the short and the long term. The effects on the economy depend to a large degree on whether – and in what way – the congestion tax is returned to the region. The effects of the Stockholm Trial on the economy have been investigated in several different studies. Most important, an overall economic analysis of the trade outlook and trade developments has been carried out in the county. Moreover, studies of the retail market, visitor-intensive activities, handicraft companies, driving schools, rubbish hauling, delivery traffic, taxis, transportation for the sick and handicapped and courier firms are also included. It is clear that the economy is dependent on a functioning road-transport system.

The short-term effect on the retail market and other sectors studied shows only small average effects. The effects often disappear among other factors which have more influence, for example new retail shops. Revenue measurements carried out show that the Stockholm Trial has had small influence on the region’s retail market. The durables survey in shopping centres, malls and department stores during the Stockholm Trial period shows that these have developed at the same rate as the rest of the country. Street-level durables sales have fallen, but the time series is too short to be able to draw conclusions (partly because VAT reporting for small companies is a long way behind).

The basis on which we judge long-term effects on companies is how companies themselves expect to act.

Earlier experience, including that from London, implies that the congestion tax results in small effects compared with the regional economy as a whole. Normal variations in the economy are generally larger than the per year effects of the congestion tax. The Stockholm Trial's contribution to total production in Stockholm County was 1 of SEK 750 billion. The congestion tax has in most cases only a marginal effect on a company's total transport costs. For households, the congestion tax has, according to the Stockholm Trial model, an effect of about one per thousand of total disposable income per year. This means that purchasing power in the county has not been significantly affected, but for individual households the tax can have tangible consequences.

Model calculations of the changed attractiveness of different areas are very sensitive to the value of time – pounds and pennies for what time is considered to be worth, what is assumed. The analysis shows many small changes that are uncertain because of this sensitivity to which assumptions are made. The changes are also small in comparison with generally increased pressure from a growing number of citizens and workplaces in the region. Even the influence on house prices is not of great significance. The long-term effects according to the model are not greater than the normal price variations between two quarters.

Cost-benefit analysis shows the congestion tax is profitable

A cost-benefit analysis is a means of systematically trying to summarize the effects and costs of a particular measure. The analysis is carried out to establish whether a measure is “worth the money”, in other words whether the value it creates is greater than its cost.

The Stockholm Trial – regarded as a short trial which, after completion, is not assumed to be repeated – creates a cost-benefit loss of about SEK 2.6 billion. Investment in and operation of the congestion-tax system makes up the greater part of the loss. This does not take into account the value of knowledge and research. This perspective is of limited interest; that the investment in the congestion-tax system was not recouped during the trial period is not a surprise.

Making the congestion-tax system permanent is calculated to yield a significant annual cost-benefit surplus of about SEK 760 million (after deducting operating costs). It would take four years to pay back the congestion-tax system's investment costs in the form of social-economic benefits. This is a very short payback time compared, for example, with road or public-transport investments which, in favourable scenarios, have a payback time in terms of cost-benefits of 15-25 years. From a cost-benefit perspective, the most relevant basis for a decision is really to ignore the cost of the investment – the Stockholm Trial cannot be undone and the investment made cannot be recouped. But the congestion tax is still cost-benefit positive, even when the cost of the investment is taken into account.

The cost-benefit surplus of the congestion tax is found, for example, in shorter travel times (worth SEK 600 million per year), increased road safety (SEK 125 million per year); and health and environmental effects (SEK 90 million per year). Revenues from the congestion tax are calculated at SEK 550 million per year (after the system's operation costs have been deducted). Every krona generated by the congestion tax results in a further 90 ore in cost-benefit gain.

Increased bus traffic is considered unprofitable from a cost-benefit perspective, both during the Stockholm Trial and if it was made permanent. Benefits are calculated to reach SEK 180 million per year, compared to a cost-benefit operational cost of SEK 340 million per year. The result should be treated carefully, however, because it is not unusual for public transport to be considered unprofitable according to a cost-benefit analysis in strict terms, while still being considered worth operating for different reasons.

Environmental effects in terms of road safety, climate and health are worth somewhat more than what the congestion tax costs road users via various types of sacrifice. Valuing and estimation of both road safety and the environment is subject to uncertainties. This uncertainty is obviously not desirable, but neither does it play a significant role in the total cost-benefit evaluation of the project.

The cost-benefit analysis looks at the average effects on all individuals in the community. For particular individuals, the consequences of the congestion tax can be both positive and negative. The net effect for different individuals depends to a large degree on how the income generated from the system is used.

Based on older research into the health effects of traffic, the congestion tax appears above all to be an accessibility measure and improved accessibility is where the big cost-benefit values lie. Health effects are small compared to the value of increased accessibility when using the somewhat older relation between emissions and health. If you instead use the latest research on the effect of traffic on health, the congestion-tax health effect increases. The total value of the environmental and safety improvements would almost double.

Discussion

Big effects compared to other measures

That vehicle traffic decreases as driving becomes more expensive is hardly surprising. An interesting question, however, is how great the effect of the Stockholm Trial is compared to other types of measures. The answer is that the reduction in traffic congestion and travel times is big compared to other measures which have been carried out or discussed in regard to Stockholm traffic. The following can be mentioned as examples:

- A new eastern connection between Nacka and the inner city (the so-called Österleden or Eastern bypass) is estimated to reduce the number of vehicles passing over inner-city bridges by approximately 14%. The equivalent reduction for a new Western bypass (bypassing the City of Stockholm) is estimated at 11%.
- The rise in the price of petrol by just under one krona (9%) which took place between April 2005 and April 2006 is estimated to have reduced traffic over the charge cordon by less than 3%.
- The zero tax on Stockholm's public transport is estimated to reduce vehicle kilometres travelled – the total of distances covered – in Stockholm County by 3 %.

It should also be remembered that road investments are expensive and roads take a long time to build. Many desirable investments in Stockholm fall into the several-billion-kronor class. For example, the Stockholm Bypass is estimated to cost SEK 20 billion and the Citybanan (a commuter-train tunnel) about SEK14 billion. Since the congestion tax instead results in a surplus of SEK 500-600 million each year, after operational costs have been deducted, it is unreasonable to set these investments *against* the congestion tax, as if they were comparable substitutes for each other. Both financially and from a traffic perspective, it is more natural to see them as complements.

At the same time, it should be pointed out that the congestion tax – even if the net effect for society is positive – does mean sacrifices for many people. These sacrifices should be set against the positive accessibility and environmental effects that the congestion tax leads to.

The significance of the Stockholm Trial as such

The Stockholm Trial resulted in a unique collection of data about traffic and its effects in Stockholm. Knowledge and competence in this area therefore increased. We briefly present some of these lessons:

For example, we can now see that improvements in travel times are so tangible that they have been perceived by the general public, which has also expressed satisfaction with this improvement. A valuable lesson of the Stockholm Trial is also that travel-time improvements occurred far from the inner city. This was not previously known.

The 10% reduction in truck passages over the charge cordon was unexpected. For the future, it would have been valuable to be able to discuss in more detail what the commercial-traffic adjustments actually look like

Many of us – though not all – were surprised that no more than about half of the motorists who “disappeared” were replaced by travellers using public transport instead. This is a sign that the number of trips is not a fixed number which can be divided into different destinations, modes of transport or times. Even though adjustment in travel-start times was seen in several studies, the substantially reduced number of vehicle journeys makes it clear that this adjustment strategy is of lesser significance. A further factor supporting this is the fact that Essingeleden has coped so well.

Adjustment to the congestion tax occurred and it took place quickly. Before the Stockholm Trial – and especially when it became clear that the trial period would be reduced to six months – there was some doubt as to whether the traffic reduction would actually take place. Would the trial be considered as something so brief and transient that it wasn’t worth changing behaviour, with people deciding instead to ‘sit out’ the trial period without adjusting travel habits? We now know that the Stockholm Trial had an immediate effect.

Since there is no direct effect to be seen on the retail market and the rest of the economy, the Stockholm Trial has revealed the possibility of reducing travel without influencing economic growth, so-called decoupling.

The Stockholm Trial provides interesting insights into what a road-toll system should look like – something which is also useful for other cities. Traffic economists have long discussed to what extent a charge-zone toll of the kind used in Stockholm is sufficient for controlling traffic in an entire city. Traffic relations change from street to street and from minute to minute. When the charge zone is as large as it is in Stockholm, there was concern that even if it had a big effect on travel over the charge cordon, streets inside the zone would soon be full of motorists already in the zone increasing travel as they realized the streets were less congested. Alternative solutions were discussed for several years prior to the Stockholm Trial, involving several sub-zones with varying rates of the congestion tax. None of the existing road-toll systems threw much light on this question. In London, it is a question of a small area in the city centre, in Singapore access to cars is also regulated and in Oslo and Bergen the system is designed to affect traffic as little as possible. The Stockholm Trial confirms that a simple charge-zone toll creates significant effects within a large area.

Prior to the possibility of the congestion tax becoming permanent, there is reason to discuss how the tax should be structured and differentiated. We believe, for example, that the charge period should be shortened somewhat in the mornings. There may also be reasons to consider whether tax levels should vary in relation to seasonal traffic variations. We have no definite answer to the question of whether it is desirable from a traffic perspective to make an exception of Essingeleden. Even though accessi-